
Endodontic treatment performed by Flemish dentists. Part 2. Canal filling and decision making for referrals and treatment of apical periodontitis

G. M. G. Hommez¹, R. J. G. De Moor¹ & M. Braem²

¹Department of Operative Dentistry and Endodontology, Ghent University, Ghent University Hospital, Dental School, Gent, Belgium; and ²Department of Dental Materials, University of Antwerp, Campus RUCA, Antwerpen, Belgium

Abstract

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Aim To gather information on root-canal treatment carried out by dentists working in Flanders (Belgium).

Methodology A questionnaire reported in a previous study was also used to gather information on canal medicaments, canal filling, and in decision making for referrals and treatment of apical periodontitis.

Results Calcium hydroxide as an interappointment dressing was used by 69.7% of the respondents. Approximately one-third of the respondents did not use any intracanal medicament. Caustic products used for pulp tissue fixation were used by 66.8% of the respondents. Cavit[®] (48.2%) and glass-ionomer (31.3%) were the temporary coronal-filling materials used most often, followed by zinc oxide–eugenol and IRM[®]. Cold lateral condensation of gutta-percha was the filling technique most used by the respondents (65.8%).

Single-cone gutta-percha placement (16%), paste techniques (4.9%) and silver points (3.9%) were still used. Resin-based sealers were used most often (88.6%). Para-formaldehyde containing sealers such as Endomethasone and N₂ were used infrequently. Approximately half of the practitioners were satisfied with their canal-filling technique, others felt that they could do better (43.0%); 0.7% were not satisfied. In cases with apical periodontitis, the size of periapical lesions and/or the presence of a root filling influenced the choice of endodontic treatment. The most common reasons for referral of endodontic cases were: retrieval of silver points, surgery, and post removal.

Conclusions The results of this study indicate that techniques and methods used for canal medication and canal filling were acceptable for the majority of the respondents. Re-treatment was underestimated as a treatment option.

Keywords: decision making, dental practice, obturation, referral, root-canal treatment, survey.

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Introduction

In Part 1 of this study (Hommez *et al.* 2003), the opinions and views of a group of Flemish dentists regarding cleaning and shaping canals during root-canal treatment were reported.

The objective of root filling is to prevent passage of microorganisms and fluid between the canal system and periradicular tissues (ESE 1994). Unfortunately, longitudinal studies of endodontic treatment in general dental practice have shown large numbers of teeth with inadequate root fillings associated with periradicular disease. This inevitably results in a growing demand for further treatment. Re-treatment is clearly indicated when a periapical lesion, clinical signs or symptoms are present (Friedman & Stabholz 1986). Despite guidelines provided to simplify endodontic re-treatment decision making (ESE 1994, AAE 1998), large intra- and

Correspondence: Professor R. J. G. De Moor, Department Operative Dentistry and Endodontology, Ghent University, Ghent University Hospital, Dental School, De Pintelaan 185, B-9000 Gent, Belgium (Tel.: +32 9 240 40 00; fax: +32 9 240 38 51; e-mail: roeland.demoor@rug.ac.be).

interindividual discrepancies remain in the estimation of endodontic re-treatment requirements (Aryanpour *et al.* 2000, McCaul *et al.* 2001). The complexity of the operative procedures and the variety of treatment alternatives introduce variation into the choice of therapy (Kvist *et al.* 1994). It has also been shown that decision making depends on the technical problems encountered and the clinical experience, confidence and training of general practitioners (Reit *et al.* 1985, Reit & Gröndahl 1987). In this respect, it is also of interest to understand how practitioners deal with apical periodontitis and which cases are referred to endodontists for speciality treatment.

The first aim of this study was to gather information on root-canal filling, carried out by a group of dentists attending peer review sessions as a part of the program of the Belgian accreditation system. Specific information was obtained on the basis of a questionnaire handed to dentists at these sessions organized by the 'Interuniversitaire Samenwerking' (Interuniversity Cooperation of the Flemish Universities) (Hommez *et al.* 2003). The aim of the questionnaire was not only to collect baseline data, but also to get an inventory of the present level of endodontic knowledge and on potential problems regarding endodontic treatment procedures.

The second aim of the study was to gain insight into endodontic treatment decision made in relation to periapical pathology and root-canal status and to make an inventory of cases considered for referral.

Materials and methods

The information for this study was gathered through a questionnaire described previously (Hommez *et al.* 2003).

The present study deals with questions on canal medicaments and access cavities. In addition, information was gathered on filling techniques, sealers and use of caustic products. Decision making of dental practitioners regarding referrals and treatment options when confronted with periapical lesions of different size were also investigated.

Results

Of the 312 questionnaires distributed, only two were not completed, giving a total of 99.4% completion; three questionnaires were discarded because the respondents did not perform endodontic treatment. In all, 307 questionnaires (98.4%) were analysed in this study.

Table 1 Use of calcium hydroxide related to the time since graduation

Graduation group (years)	Number of respondents		
	Ca(OH) ₂	Total in group	% Ca(OH) ₂
0–5	28	35	80.0
6–10	37	49	75.5
11–15	39	54	72.2
16–20	44	69	63.8
21–25	31	50	62.0
>25	35	50	70.0

Intracanal medication and temporary coronal-filling material

Calcium hydroxide was used as an interappointment medicament by 69.7% of the practitioners. Approximately one-third (29.6%) of the practitioners did not use any dressing. Other nonspecified intracanal medicaments were used by 6.8% of the practitioners. The use of calcium hydroxide by year of graduation of the respondents is given in Table 1. There was no statistically significant difference between the age groups ($P > 0.05$), although there was a trend towards reduced use in the older age groups of the dentists.

Table 2 describes the use of caustic products in root-canal treatment by the respondents. These chemicals were used by 66.8% of the respondents; Rockless[®] (Spécialités Septodont, Saint Maur, des Fossés, France) was used by most (34.2%) followed by Tempofore[®] (Spécialités Septodont) 26.4%. The preparation containing arsenic (Caustinerf Arsenic[®]) was used by 2.3% of the respondents. There was no statistically significant difference between the different graduation groups (time since graduation) as related to the use of caustic products ($P > 0.05$).

Table 3 summarizes the materials used for temporary filling of access cavities. Cavit[®] (ESPE, Neus, Germany) was used by 48.2% of the respondents, followed by glass-ionomer (31.3%), zinc oxide–eugenol (27.0%) and IRM[®] (Dentsply De Trey, Konstanz, Germany) 15.3%. Resin composite (1.6%) and amalgam (1.6%) were seldom used and other unspecified materials were used by 5.2% of the respondents. The time since graduation had no statistically significant influence ($P > 0.05$) on the choice of temporary filling material.

Filling of the root canal

The different techniques used by the respondents to fill root canals are listed in Table 4. Cold lateral condensation of gutta-percha was the technique used by

Table 2 Caustic products used during root-canal therapy according to the period since qualification

Product	Main toxic components	Period since qualification						Total	%
		0–5	6–10	11–15	16–20	21–25	>25		
Caustinerf arsenic [®]	30% arsenicum anhydride	2	0	0	1	2	2	7	2.3
Caustinerf nonarsenic [®]	46% paraformadehyde	2	3	2	10	2	6	25	8.1
Pulperyl [®]	29% creosote	8	3	2	10	4	7	34	11.1
Toxavit [®]	30–50% paraformadehyde	1	0	0	0	0	0	1	0.3
Rockless [®]	32% formaldehyde	14	15	17	27	12	20	105	34.2
CHKM [®]	27% chlorophenol	1	3	5	13	5	12	39	12.7
Crésophène [®]	30% paramonochlorophenol	1	1	4	4	4	2	16	5.2
Tempofore [®]	12.6% iodoform + 1–5% creosote	13	13	18	16	14	7	81	26.4
Other		1	3	4	5	3	3	19	6.2
None		10	16	22	22	17	15	102	33.2

Caustinerv arsenic[®], Caustinerv nonarsenic[®], Pulperyl[®], Rockless[®], Crésophène[®], Tempofore[®]: Spécialités Septodont, Saint Maur, des Fossés, France.

Toxavit[®]: Lege artis Pharma GmbH, Dettenhausen, Germany.

CHKM[®]: Spécialités Septodont, Saint Maur, des Fossés, France.

Table 3 Materials used for temporary filling of the access cavity according to the period since qualification

Material	Period since qualification						Total	%
	0–5	6–10	11–15	16–20	21–25	>25		
Cavit [®]	21	25	26	36	21	19	148	48.2
Glass-ionomer	16	16	19	16	14	15	96	31.3
Zinc oxide–eugenol	6	15	10	24	13	15	83	27.0
IRM [®]	6	6	10	7	8	10	47	15.3
Composite	0	1	3	0	0	1	5	1.6
Amalgam	0	2	2	1	0	0	5	1.6
Other	4	2	4	2	2	2	16	5.2

Cavit[®]: ESPE, Neus, Germany.

IRM[®]: Dentsply DeTrey, Konstanz, Germany.

Table 4 Techniques used to obturate the root canal according to the period since qualification

Technique	Period since qualification						Total	%
	0–5	6–10	11–15	16–20	21–25	>25		
Cold lateral condensation	29	35	39	45	30	24	202	65.8
Single-cone gutta-percha	1	4	9	16	7	12	49	16.0
Thermafil [®]	7	8	9	5	7	2	38	12.4
Vertical condensation	5	3	10	8	4	6	36	11.7
Warm lateral condensation	5	5	6	6	5	4	31	10.1
Thermomechanical gutta-percha compaction	5	2	6	2	2	0	17	5.5
Paste technique	0	0	1	2	3	9	15	4.9
Silver point	0	3	1	3	3	2	12	3.9
Soft-Core [®]	0	1	0	0	1	0	2	0.7
Other	0	1	4	1	2	1	9	2.9

Thermafil[®]: Maillefer, Ballaigues, Switzerland.

Soft-Core[®]: Soft-Core DPAPS, Copenhagen, Denmark.

most respondents (65.8%). The other techniques were used infrequently (in descending order): single-cone gutta-percha (16.0%), Thermafil[®] (Maillefer, Ballaigues, Switzerland) (12.4%), vertical condensation (11.7%), warm lateral condensation (10.1%), thermomechanical compaction of gutta-percha (5.5%), paste technique

(4.9%), silver points (3.9%) and Soft-Core[®] (0.7%) (Soft-Core DPAPS, Copenhagen, Denmark). Cold lateral condensation was used by 82.9% of the respondents who had graduated in the latest 5 years (Table 5). This percentage dropped with the time since graduation to 48.0% of the respondents who had graduated more than

Table 5 Root-canal obturation technique related to the time since graduation

Root-canal obturation technique	Time since graduation					
	0–5	6–10	11–15	16–20	21–25	>25
Cold lateral condensation	29 (82.9%)	35 (71.4%)	38 (70.4%)	46 (66.7%)	30 (60.0%)	24 (48.0%)
Single-cone gutta-percha	1	4	9	16	7	12
Thermafil [®]	7	8	9	5	7	2
Vertical condensation	5	3	10	8	4	6
Warm lateral condensation	5	5	6	6	5	4
Thermomechanical gutta-percha compaction	5	2	5	3	2	0
Paste technique	0	0	1	2	3	9
Silver point	0	3	1	3	3	2
Soft Core [®]	0	1	0	0	1	0
Other	0	1	4	1	2	1

Table 6 Root-canal sealers used by the respondents

Root-canal sealer	Type of root-canal sealer	No. of respondents	%
AH-plus [®]	Epoxy resin sealer	116	37.8
AH-26 [®]	Epoxy resin sealer	106	34.5
Topseal [®]	Epoxy resin sealer	50	16.3
Sealapex [®]	Resin and calcium hydroxide sealer	46	15.0
Endomethasone [®]	ZOE sealer + paraformaldehyde + dexamethasone	36	11.7
Tubliseal [®]	ZOE sealer	36	11.7
Zinc oxide–eugenol	ZOE sealer	22	7.2
N ₂ [®]	ZOE sealer + paraformaldehyde	6	2.0
Ketac-Endo [®]	Glass-ionomer sealer	3	1.0
Grossman's sealer [®]	ZOE sealer	2	0.7
Other		5	1.6

AH-plus[®], AH-26[®]: De Trey Dentsply, Konstanz, Germany.

Topseal[®]: Maillefer, Ballaigues, Switzerland.

Sealapex[®], Tubliseal[®]: Kerr Corporation, Orange, CA, USA.

Endomethasone[®]: Spécialités Septodont, Saint Maur, des Fossés, France.

N₂[®]: Hager & Werken GmbH, Duisburg, Germany.

Ketac-Endo[®]: ESPE, Neus, Germany.

Grossman's sealer[®]: Cartensen, Medex Omicron, Buenos Aires, Argentina.

25 years ago. Conversely, the use of single-cone gutta-percha techniques and pastes increased with age.

Table 6 lists the root-canal sealers used by the respondents. AH-plus[®] (Dentsply De Trey) was used by 37.8% of the respondents followed by 34.5% for AH-26[®] (Dentsply De Trey). The other sealers listed in descending order of preference were: Topseal[®] (Maillefer) 16.3%; Sealapex[®] (Kerr Corporation, Orange, CA, USA) 15.0%; Endomethasone[®] (Spécialités Septodont, Saint Maur, des Fossés, France) 11.7%; Tubliseal[®] (Kerr Corporation) 11.7%; Zinc oxide–eugenol, 7.2%; N₂[®] (Hager & Werken GmbH, Duisburg, Germany) 2.0%; Ketac-Endo[®] (ESPE) 1.0% and Grossman's sealer[®] (Cartensen, Medex Omicron, Buenos Aires, Argentina) 0.7%. Table 7 describes the root-canal sealers used in relation to the obturation technique.

Nearly half the respondents (48.9%) were satisfied with their filling technique, 43.0% felt that they could

perform better, 0.7% were not satisfied and 7.5% did not answer the question.

Endodontic (re)treatment decision making

Four out of five respondents performed root-canal re-treatments. The following solvents were used in descending order: chloroform (36.5%); Endosolv E[®] (Spécialités Septodont) (8.8%); Endosolv R[®] (Spécialités Septodont) (5.2%); turpentine (4.2%); other not specified solvents were used by 3.9%. One-quarter of the respondents (25.4%) never used solvents during endodontic re-treatment.

The respondents were asked to rate their attitude towards referring endodontic cases on a scale from 1 to 10. A score of 1 meant the practitioner did not refer, whilst 10 meant the practitioner was enthusiastic about endodontic referral. The majority rated between 1 and 5

Table 7 Root-canal sealer used in relation to the obturation technique

Root-canal obturation technique	Root-canal sealer										
	AH-plus®	AH-26®	Topseal®	Sealapex®	Endomethasone®	TubliSeal®	Zinc oxide–eugenol	N ₂ Sargenti®	Ketac-Endo®	Grossmans sealer®	Other
Cold lateral condensation	89	78	38	32	13	23	19	2	2	2	0
	14	17	6	9	15	9	4	2	1	1	3
	15	17	15	8	0	7	0	0	0	0	0
Thermafil®	15	17	3	3	4	3	0	0	2	0	1
	14	10	6	3	4	6	0	1	1	0	2
Warm lateral condensation	9	10	5	3	0	3	1	0	0	0	0
	Thermomechanical gutta-percha compaction	7	1	3	1	9	5	3	2	0	0
4		6	0	2	2	7	1	0	0	0	1
0		1	0	1	0	0	0	0	0	0	0
2		3	0	3	2	0	0	0	0	0	0
Other											

(64.5%); only 35.5% rated endodontic referral more than 5.

Table 8 gives an overview on treatment decision making in specific situations. When no root filling was present and a periapical lesion less than 1 cm wide was seen on a radiograph, the majority of the respondents (90.9%) performed conventional root-canal treatment in one or more visits. If the periapical lesion, in absence of a root filling, was wider than 1 cm, the number of respondents that chose conventional root-canal treatment dropped to 57.3%. In addition, more respondents chose conventional root-canal treatment followed by an apicectomy (26.4%), referral to an endodontist (18.2%) and extraction (8.5%) as a treatment option.

When a root filling was present and a small lesion (less than 1 cm wide) was visible on a radiograph, 62.5% of the respondents chose conventional root-canal re-treatment; 12.7% elected for apicectomy, 15.0% of cases would be referred. When a periapical lesion of more than 1 cm wide in combination with a root filling was present, the decisions of the respondents were ambiguous. Only 31.2% would perform root-canal re-treatment, 27.0% would carry out a root-canal re-treatment followed by an apicectomy. Referral in these cases was frequently chosen (24.8%) as well as apicectomy alone (17.3%) and extraction (15.0%). In these four situations, the older practitioners opted more often for referral.

Table 9 gives an overview of cases that respondents would consider for referral to an endodontist. Retrieval of silver points was the most popular reason for referral (56.7%), followed by surgical closure of perforations (47.6%) and surgical interventions (45.9%). Other referral cases in descending order were: post removal (39.4%), dens invaginatus (38.4%), trauma (37.1%), mutilated canal (36.2%), canal splitting in the apical third (34.9%), internal root resorption (33.9%), S-shaped (bayonet shaped) root canal (33.6%), calcified canal (33.2%), curved root canal (32.9%), missed canal (32.2%), external resorption (31.6%), root perforation (28.3%), large periapical lesion (25.1%), endodontic re-treatment (15.6%), apexification procedure (15.3%), endodontic treatment of deciduous teeth (7.5%) and treatment of molar teeth (5.5%).

Discussion

Calcium hydroxide is recommended as the standard intracanal dressing in root-canal treatment (Byström *et al.* 1985, Sjögren *et al.* 1991). In the present study, calcium hydroxide was used by 69.7% of the respondents, which is considerably more than the 21.1% in the study

Table 8 Endodontic (re)treatment decision making in relation to periapical pathology and root canal status

Treatment chosen	No root-filling periapical lesion		Root-filling periapical lesion	
	<1 cm	>1 cm	<1 cm	>1 cm
Root-canal treatment	279 (90.9%)	176 (57.3%)	192 (62.5%)	96 (31.2%)
Root-canal treatment + apicectomy	17 (5.5%)	81 (26.4%)	33 (10.7%)	83 (27.0%)
Apicectomy	7 (2.3%)	13 (4.2%)	39 (12.7%)	53 (17.3%)
Extraction	3 (1.0%)	26 (8.5%)	8 (2.6%)	46 (15.0%)
Referral	16 (5.2%)	56 (18.2%)	46 (15.0%)	76 (24.8%)
Other	7 (2.3%)	9 (2.9%)	25 (8.1%)	15 (4.9%)

More than one option was chosen by several practitioners.

Table 9 Endodontic referral cases according to the number of respondents (*n* = 307)

Case to refer	<i>n</i>	%
Retrieval of silver point	174	56.7
Corrective surgery: closure of perforation	146	47.6
Surgical intervention	141	45.9
Post retrieval	121	39.4
Dens invaginatus	118	38.4
Trauma	114	37.1
Mutilated canal	111	36.2
Canal split in apical third	107	34.9
Internal resorption	104	33.9
S-shape (bayonet)	103	33.6
Calcified canal	102	33.2
Curved root canal	101	32.9
Missed canal	99	32.2
External resorption	97	31.6
Perforation	87	28.3
Large periapical lesion	77	25.1
Re-treatment in general	48	15.6
Apexification procedure	47	15.3
Deciduous teeth	23	7.5
Molars in general	17	5.5
Other	4	1.3

of Saunders *et al.* (1999), the 7% in the study of Jenkins *et al.* (2001) in the UK or the 9% in the USA (Whitten *et al.* 1996). In a Dutch study (Siers *et al.* 2001), the percentage of respondents using calcium hydroxide was 86.2%. These differences between countries are likely to be attributed to the different policies in dental training between universities (Qualtrough *et al.* 1999). Although there was no statistically significant difference between the different age groups in this study, a similar trend, namely a decreased use of calcium hydroxide as a function of the period since graduation of the participants (Table 1) was observed as in some of the previous studies (Saunders *et al.* 1999, Jenkins *et al.* 2001). About one-third of the practitioners did not use an interappointment medicament. Studies have shown that it is almost impossible to create a sterile root canal through cleaning and shaping of the root-canal system and that regrowth of

bacteria occurs in an empty root canal (Byström & Sundqvist 1981, Siqueira *et al.* 2002). Therefore, an intra-canal dressing is advocated between appointments when a tooth is treated in more than one session.

Caustic and organic root-canal disinfectants were used by 66.8% (Table 2), despite the well-established use of calcium hydroxide. These products contain organic components such as paraformaldehyde, chlorophenol, parachloromonophenol, creosote, arsenicum anhydride, iodoform. It has been argued that most of these products should be prohibited as they are highly toxic, allergenic, mutagenic and carcinogenic and are harmful to patients (Lewis 1998). It has been shown that some of these products caused periodontal destruction and delayed healing of periapical tissues (Kopczyk *et al.* 1986, Yamasaki *et al.* 1994, Di Felice & Lombardi 1998), as they can escape from the root canal. In this respect, studies have documented their rapid and strong systemic distribution when used during endodontic treatment (Block *et al.* 1983, Fager & Messer 1986).

The sealing of access cavities between appointments is a determining factor in the inhibition of bacterial leakage and hence the prognosis of root-canal treatment (Saunders & Saunders 1994). Cavit[®] is the product most favoured by Belgian practitioners (48.2%), with glass-ionomers being used by 31.3% of the respondents. Studies have shown that Cavit[®] adequately sealed access cavities of endodontically treated teeth (Beach *et al.* 1996), although a bacterial study (Barthel *et al.* 1999) reported that glass-ionomer was superior to Cavit[®].

Cold lateral gutta-percha condensation was the filling technique most frequently used (Table 4). Although it is common knowledge that single-cone gutta-percha fillings are not recommended (Beatty 1987), it was still used by 16.0% of the respondents. The results in Table 5 show that different types of warm gutta-percha filling techniques were used by all ages. This clearly shows the effort made by a number of practitioners to use other filling techniques than those taught during dental graduate training.

This study also provided information on the endodontic decision making of the participants. On one hand, re-treatment of failed root fillings was the standard choice by the majority of the respondents (Table 8). On the other hand, there was a clear trend towards more apicectomies and extractions with the increase of the size of the periapical lesion. The number of apicectomies and extractions even increased when the lesion was associated with root-filled teeth. Studies have shown that the size of the periapical lesion is not a determining factor in healing (Sjögren *et al.* 1990). The presence of a root filling is also no reason for more radical treatments. Re-treatment should always be the first option, although a number of complicating factors require surgery (Walton & Torabinejad 1996).

Conclusion

The use of calcium hydroxide was well established. Cautic products were used by some. The temporary seal of access cavities was in general provided by favoured materials. Most practitioners also used favoured filling techniques in combination with resin-based sealers, although some relied on single-cone (gutta-percha or silver points) techniques. Re-treatment in failed cases was not the first option for the majority of practitioners; surgery was preferred by most. Referral of difficult cases to an endodontist was not common practice.

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